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Ingerana borealis (Annandale, 1912): a new record from Mizoram (India), with notes on its systematic position and natural history

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A study on the distribution of *Ingerana borealis* was carried out in Mizoram. Based on morphological comparison with type species of the genera *Ingerana*, *Occidozyga* and *Phrynoglossus* and data on behaviour, *Micrixalus borealis* is allocated to the genus *Ingerana* Dubois, 1987. The study also reveals its occurrence up to 1000 m asl, previously unrecorded for this species. The species lives in lotic habitat and is well adapted not only to the slow-moving waters, but also to the fast flowing permanent streams in and near forests. The holophoront of *Micrixalus borealis* is redescribed and recently collected specimens from Mizoram allocated to this species are described.

INTRODUCTION

ANNANDALE (1912) described *Micrixalus borealis* from the collections of the Abor Expedition based on 11 specimens. It was only DUBOIS (1987) who reconsidered generic allocation of this species using the character states given in original description. He allocated the species to *Phrynoglossus* Peters, 1867 as it shares with this genus the absence of vomerine teeth, the enlarged, rounded finger and toe tips without grooves and the indistinct tympanum. Morphological data and recent phylogenetic studies showed that *Phrynoglossus* and *Occidozyga* Kuhl & Van Hasselt, 1822 are members of a monophyletic clade (MARMAYOU et al., 2000;

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Kosuch et al., 2001) transcribed by Fei et al. (1990) and Dubois (2005) as the subfamily *Occidozyginae* Fei, Ye & Huang, 1990, and by others (Inger, 1993; Frost et al., 2006) by synonymisation of *Phrynoglossus* with *Occidozyga*. Thus, *Micrixalus borealis* was listed as *Occidozyga borealis* by Frost et al. (2006). The *Occidozyginae* might include further ranoid groups as molecular data (Bossuyt et al., 2006) indicate close relationship of *Occidozyga lima* (Gravenhorst, 1829), *O. laevis* (Günther, 1859) and *Ingerana tenasserimensis* (Sclater, 1892).

In the last decade, more specimens of *Micrixalus borealis* from a large range including Bangladesh, Bhutan, NE India and Myanmar have been collected and observed in the wild and the onomatophore deposited in the collection of Zoological Survey of India, Kolkata, has been studied. At present, *M. borealis* is known from several north-eastern states of India, including Arunachal Pradesh, Meghalaya (Matthew & Sen, 2003) and Nagaland (Ao et al., 2003). Outside India, it has also been recorded from Bhutan (Dubois, pers. comm.) and from the Rangamati Hill district in Bangladesh and the Arkan state in Myanmar (Frost et al., 2006). We report here its occurrence in the Mizoram state of north-eastern India.

Recent observation of new specimens and behavioral data from the field made generic allocation to either *Phrynoglossus* or *Occidozyga* somehow doubtful. Therefore *Micrixalus borealis* is compared to specimens of the genera *Occidozyga*, *Phrynoglossus* and *Ingerana* as defined by their onomatophores and a new generic allocation is proposed. We provide a description of these newly collected specimens, along with diagnostic characters for the species, its distribution and ecological notes. For the sake of completeness, a redescription of the onomatophore of *Micrixalus borealis* is given.

Material and methods

Museum abbreviations. – BMNH, Natural History Museum, London, United Kingdom; MNHN, Muséum National d'Histoire Naturelle, Paris, France; ZMB, Zoologisches Museum Berlin, Berlin, Germany; ZSI, Zoological Survey of India, Kolkata, India.

Specimens studied. – Mizoram. *Aizawl district*: MZU-ZOO A.108, A.115, A.118, 3 ♀, Mizoram University Campus (23°43.081'N, 92°43.668'E; 915 m asl); MZU-ZOO A.36, A.38, 1 ♂, 1 ♀, Tamdil National Wetland (23°44.399'N, 92° 57.313'E; 745 m asl); MZU-ZOO A.43, A.46, 1 ♂, 1 ♀, Durlui (23°53.508'N, 92°29.056'E; 110 m asl). *Kolasib district*: MZU-ZOO A.31, A.33-34, 1 ♂, 2 ♀, Tuitun stream (23°58.213'-58.402'N, 92°41.055'-41.104'E; 300-325 m asl); MZU-ZOO A.122, 1 ♂, Zanlawntlang Reserved Forest (23°56.116'N, 92°43.465'E; 748 m asl).

Our specimens were collected and preserved in 8 % formalin. Ecological and morphometric data were collected for all specimens. Voucher specimens were catalogued in the Museum of Zoology department, Mizoram University (MZU-ZOO). Selected morphometric measurements were made to the nearest 0.01 mm with dial calipers (Mitutoyo series No. 505-671). Morphometric and meristic characters largely followed those of Sengupta (2008). Onomatophore description follows the standards of Ohler & Dubois (2006) and Bordoloi et al. (2007).

Other specimens used for comparisons. – *Ingerana borealis* (Annandale, 1912): ZSI 16932, holophoront, sex not investigated, Rotung (1300 ft = 400 m asl; 28°07'N, 95°12'E), South of

Source : MNHN, Paris

Yembung, Arunachal Pradesh, India; MNHN 1994.6489-6492, 4 ♂, Deothang (1000 m asl; 226°53'N, 91°30'E), Samdrup Jongkhar District, Bhutan. *Ingerana tenasserimensis* (Sclater, 1892): ZSI 10429, symphoront, sex not investigated, Tenasserim expedition (near 12°04'N, 99°01'E), Myanmar; MNHN 1989.0718-0719, Banthat Mts. (7°30'N, 99°40'E), Thailand. *Occidozyga lima* (Gravenhorst, 1829): MNHN 1999.6112-6132, Luang Prabang (19°53'N, 102°08'E), Laos. *Phrynoglossus martensii* Peters, 1867: ZMB 5645, holophoront, young ♀ Bangkok (13°34'N, 100°13'E), Thailand; MNHN 1997.5359-5369, 9 ♂, 2 ♀, Ben En National Park (19°35'N, 105°28'E), Thanh Hoa Province, Vietnam.

Measurements. – SVL, snout-vent length; SL, snout length; EN, distance from eye to nostril; NS, distance from nostril to snout; TE, distance from tympanum to eye; IN, internarial distance; IOD, interorbital distance; IUE, distance between upper eyelids; UEW, upper eyelid width; ED, eye diameter; HTYD, horizontal tympanic diameter; HL, head length; HW, head width; HDN, head depth at nostril; MN, distance from back of mandible to nostril; MFE, distance from back of mandible to front of eye; MBE, distance from back of mandible to back of eye; IFE, distance between front of eyes; IBE, distance between back of eyes; FLL, forelimb length; HAL, hand length; F_1, length of first finger; F_2, length of second finger; F_3, length of third finger; F_4, length of fourth finger; HLL, hindlimb length; TL, shank length; TW, shank width; FL, thigh length; T_1, length of first toe; T_2, length of second toe; T_3, length of third toe; T_4, length of fourth toe; T_5, length of fifth toe; IMT, length of inner metatarsal tubercle; F_1D, width of first finger disc; F_3D, width of third finger disc; T_1D, width of first toe disc; T_4D, width of fourth toe disc; MTTF, distance from distal edge of metatarsal tubercle to maximum incurvation of web between third and fourth toe; TFTF, distance from maximum incurvation of web between third and fourth toe to tip of fourth toe; MTFF, distance from distal edge of metatarsal tubercle to maximum incurvation of web between fourth and fifth toe; FFTF, distance from maximum incurvation of web between fourth and fifth toe to tip of fourth toe.

GENERIC ALLOCATION

Comparison of morphological characters (tab. 1) of specimens allocated to *Micrixalus borealis* and specimens of *Ingerana*, *Occidozyga* and *Phrynoglossus* present quite a complex pattern of variation. In fact some character states, as the absence of vomerine teeth, apply to all species observed and might be variable within genera, as *Ingerana tasanae* (Smith, 1921), a larger species allocated to the genus *Ingerana*, has vomerine teeth (TAYLOR, 1962). *Occidozyga lima* can be distinguished by a series of character states that should be autapomorphies in cladistic analysis, such as the presence of an outer metatarsal tubercle and of a tarsal tubercle, the pointed tongue shape, the pointed tit-like subarticular tubercles, the complete webbing, the pearly tipped tubercles on dorsal and ventral skin and the colour pattern on posterior shank which shows continuous dark and light transverse stripes (DUBOIS & OHLER, 2001). These character states cannot be observed in either *Ingerana tenasserimensis*, *Phrynoglossus martensii* or *Micrixalus borealis*. *Phrynoglossus martensii* can be distinguished from *Ingerana* by the length of first finger (longer than second), the absence of grooves on discs, the presence of a metatarsal web, and the skin bearing glandular warts. It shares with *Occidozyga lima* the presence of metatarsal web.

Source : MNHN, Paris

Table 1. – Comparison of 22 characters, including data on behaviour, observed on specimens of the type species of the genera *Ingerana*, *Occidozyga* and *Phrynoglossus* with the holophoront (holotype) of *Micrixalus borealis*.

Genus	*Occidozyga*	*Phrynoglossus*	*Ingerana*	*Micrixalus borealis*
Type species or holophoront	*Rana lima* Gravenhorst, 1829	*Phrynoglossus martensii* Peters, 1867	*Rana tenasserimensis* Sclater, 1892	ZSI 16932
Vomerine teeth	Absent	Absent	Absent	Absent
Tongue	Pointed	Rounded	Notched	Notched
Tympanum	Indistinct	Indistinct	Distinct	Indistinct
Tympanic fold	Poorly distinct	Distinct	Distinct	Distinct
Length of finger I	Equal to II	Longer than II	Much shorter than II	Much shorter than II
Tips of fingers	Pointed	Rounded	Dilated	Dilated
Grooves on digital discs	Absent	Absent	Present	Absent
Subarticular tubercles	Prominent, pointed	Rounded	Rather large, flat, indistinct	Large, distinct
Outer metatarsal tubercle	Present	Absent	Absent	Absent
Tarsal tubercle	Present	Absent	Absent	Absent
Webbing	Complete	Large	Small	Moderate
Metatarsal web	Present	Present	Absent	Absent
Tarsal fold	Long, distinct	Short, distinct	Short, indistinct	Short distinct
Dorsal skin	Pearly tipped tubercles or spines	Scattered tubercles	Fine net-like skin ridges	Fine net-like skin ridges
Ventral skin	Pearly tipped tubercles or spines	Smooth	Smooth	Smooth
Lateral line system	Present	Absent	Absent	Absent
Coloration	Greyish brown with darker pattern forming two more or less distinct mid-dorsal lines	Greyish brown with mid-dorsal darker band outlined by lighter lines	Usually light dorsolateral stripes; brown with darker spots and scattered white blotches	Greyish brown, darker pattern including band between eyes and chevron; lighter dorsolateral lines
Posterior shank	Continuous dark and light transverse stripes	Whitish with a fine peppering of darkish pigment	Brown, slightly lighter mottled	Brownish mottling
Vocal sacs	Internal vocal sac	Internal vocal sacs	Not known	Internal vocal sacs
Nuptial spines	Present	Present	Not known	Present
Colour of egg	Brown and white	Whitish	Whitish	Whitish
Amplexus	Axillary	Lumbar	Not observed	Axillary
Habitat	Ponds, paddy field	Ditches, marshes	Streams, cascades	Streams, cascades

If we try to allocate *Micrixalus borealis* using these characters, it does not share tongue shape, extension of web, presence of pearl-tipped tubercles nor colour pattern of posterior shank with *Occidozyga lima*. It does not share longer finger I, presence of metatarsal web and glandular warts on skin with *Phrynoglossus martensii*. *Micrixalus borealis* has a notched tongue, a finger I much shorter than finger II, its shank shows not longitudinal pattern, its

Source : MNHN, Paris

metatarsal web is absent and its skin shows fine net-like skin ridges. It shares the absence of metatarsal web and the presence of these particular skin ridges with *Ingerana tenasserimensis*.

Considering behavioral characters, *Micrixalus borealis* specimens were collected in lotic habitat as were specimens of *Ingerana tenasserimensis*. *Occidozyga lima* is often found calling in ponds and paddy fields in open habitat. *Phrynoglossus martensii* is present in ditches and marshes in open habitat or secondary forests. *Phrynoglossus martensii* was described from Bangkok, its tadpole was first described from this town and it still can be found there everywhere. The ecological niche of *Micrixalus borealis* clearly is distinct from that of *Phrynoglossus* and *Occidozyga*, but corresponds to the niche of *Ingerana*. This supports change of generic allocation.

On behalf of these morphological and behavioral characters, *Micrixalus borealis* should be allocated to the genus *Ingerana* as *Ingerana borealis*. It is distinct from the two species presently allocated to this genus by its smaller size, absence of grooves on tip of fingers and toes and larger webbing.

SPECIFIC ALLOCATION

Comparison of the newly collected specimens with the onomatophore of *Micrixalus borealis* (ZSI 16932; see below) confirms specific allocation. The specimens from Mizoram correspond in general shape and size. They share the presence of a tooth like projection on lower jaw, rounded finger tips, relatively small webbing. Some character states differ. In the onomatophore, the tympanum is indistinct and no measurements have been taken, whereas in the specimens from Mizoram it is not very distinct but measurements could be taken. Differences in toe tip shape and presence of short groove may be consequences of poor conservation conditions of the onomatophore. Nevertheless some of the differences might indicate intraspecific variation over the range of *Ingerana borealis*. More comparative studies are needed to test this hypothesis.

DIAGNOSIS

Ingerana borealis is characterized by a combination of the following characters. Body and head: small-sized frog; head small and triangular; snout bluntly rounded, projecting in profile; canthus rostralis obtuse; loreal region concave; width of upper eyelid less than interorbital distance; tympanum rounded; supratympanic fold present; vomerine teeth absent; apical projection at the lower jaw prominent, pointed; a white spot between eye and upper jaw; a dark bar between eyes. Legs: fingers free; toes half webbed; metatarsal web absent; larger subarticular tubercles on toes than on fingers; outer metatarsal tubercle absent; inner metatarsal tubercle elongated, followed by tarsal fold; tips of digits dilated, rounded, grooves absent. Skin and colour: dorsum and flanks with net-like ridges and with tiny glandular warts; venter smooth, whitish yellow; dorsal colour grey or brown (in 8 % formalin) with light dorsolateral band. Sex characters: calling male with a pair of indistinct gular pouches on throat; females with 58-72 unpigmented eggs.

Source : MNHN, Paris

Table 2. – Measurements and some natural history parameters of *Ingerana borealis* from Mizoram, India.

Collection number	MZU-ZOO A.31	MZU-ZOO A.33	MZU-ZOO A.34	MZU-ZOO A.36	MZU-ZOO A.38	MZU-ZOO A.43	MZU-ZOO A.46	MZU-ZOO A.108	MZU-ZOO A.115	MZU-ZOO A.118	MZU-ZOO A.122
Sex	Female	Male	Female	Male	Female	Male	Female	Female	Female	Female	Male
Locality	Tuitun	Tuitun	Tuitun	Tamdil National Wetland	Tamdil National Wetland	Durlui	Durlui	MZU Campus	MZU Campus	MZU Campus	Zanlawntlang RF
SVL	24.50	21.9	23.14	21.82	24.7	19.96	24.35	25.54	28.12	28.08	23.95
SL	3.40	3.00	3.30	3.02	3.4	3.00	3.32	3.84	3.61	3.85	2.1
EN	2.82	1.45	1.62	1.37	1.60	1.58	1.64	1.90	1.68	1.47	1.22
NS	1.75	1.62	1.60	1.42	1.58	1.32	1.74	2.00	1.80	1.53	1.54
TE	0.86	0.67	0.94	0.90	0.74	0.82	1.03	1.02	1.18	1.23	0.98
IN	2.22	2.47	2.67	2.56	2.68	2.02	2.32	2.75	2.98	3.16	2.20
IOD	2.67	2.22	2.30	2.27	2.52	2.14	2.66	2.72	2.82	2.07	2.07
UEW	1.73	2.00	2.10	1.95	2.14	1.64	1.75	2.38	2.32	2.06	2.16
ED	2.8	2.9	3.33	3.33	3.06	2.96	3.38	3.62	3.36	3.38	3.23
HTYD	1.84	1.62	2.16	1.62	2.10	1.90	2.10	2.44	2.30	2.18	1.82
HL	7.24	5.96	6.00	6.50	6.50	5.68	7.75	7.74	8.40	7.75	6.85
HW	7.69	7.82	7.96	7.98	8.42	6.96	8.52	8.64	9.06	9.35	8.40
HDN	3.29	2.74	2.82	2.60	2.94	2.50	2.70	2.48	2.88	2.90	2.53
MN	5.52	4.36	5.07	5.32	5.27	4.42	5.16	5.31	5.40	5.33	5.10
MFE	3.96	3.55	3.73	4.14	4.40	3.32	3.88	4.15	4.05	4.95	4.10
MBE	1.82	2.24	2.00	2.65	2.55	1.76	1.85	2.20	2.48	2.68	1.50
IFE	4.04	3.58	4.03	3.95	3.94	3.26	3.80	4.60	4.90	4.48	3.90
IBE	5.61	5.58	5.96	5.60	5.98	5.00	5.86	6.64	6.92	6.66	5.65
FLL	13.74	11.7	12.9	12.42	13.70	11.44	14.10	15.06	15.14	14.82	13.15
F1	4.30	3.12	4.08	3.34	4.26	3.48	4.82	4.60	4.92	5.27	3.80
F2	4.92	4.04	4.80	3.94	4.83	3.90	5.02	5.15	5.22	5.62	4.12
F3	6.32	5.20	5.92	5.46	6.50	5.12	6.36	6.56	6.72	6.85	5.70
F4	5.84	4.58	5.10	4.30	5.62	4.12	5.23	5.46	6.14	5.94	4.86
F_1D	0.68	0.52	0.73	0.65	0.69	0.58	0.76	0.73	0.83	0.76	0.54
F_4D	0.77	0.54	0.86	0.80	0.91	0.68	0.92	0.66	0.90	0.87	0.58
HLL	36.63	33.40	36.18	34.06	35.10	30.96	40.87	41.20	44.28	41.93	35.44
TL	12.26	11.58	12.76	11.47	13.00	10.44	13.44	13.15	14.07	14.12	11.94
TW	3.22	3.52	3.67	3.90	4.60	3.02	3.68	4.68	4.55	4.43	3.10
T1	4.34	4.30	5.07	5.25	5.53	3.78	4.88	5.56	5.40	5.68	4.77
T2	6.24	5.86	6.55	6.98	7.56	5.72	7.35	7.83	7.20	7.46	6.60
T3	8.43	8.40	9.28	8.78	9.86	8.30	9.78	10.72	10.48	10.94	9.22
T4	10.94	10.72	11.84	11.32	12.60	9.45	12.66	13.26	13.21	14.10	11.34
T5	8.38	7.84	9.10	8.50	9.57	7.14	8.64	10.38	10.23	10.58	8.70
T_1D	0.78	0.78	1.08	0.86	1.02	0.52	0.98	0.76	1.00	1.00	0.75
T_4D	0.76	0.84	1.00	1.00	1.07	0.74	1.02	0.82	1.06	1.14	0.79
IMT	1.42	1.2	1.36	1.80	1.38	1.08	1.88	1.18	1.92	1.93	1.48
Tibio-tarsal articulation	Anterior corner of eye	Posterior corner of eye	Middle of eye	Middle of eye	Anterior corner of eye	Middle of eye	Between eyes and nostril	Between eyes and nostril	Anterior corner of eye	Anterior corner of eye	Anterior corner of eye
Gut content	Hymenoptera, isopteran nymph	Adult winged Isoptera, Diptera	–	Isopteran nymphs (2)	Diptera (2), Hymenoptera	Diptera	Isopteran wings	Isopteran worker, winged Isoptera (2)	Adult wingless Isoptera (2), isopteran nymph, small Myrmicidae	–	–
No. of eggs	68	–	65	–	72	–	–	58	62	67	–
Size of eggs	1.43-2.20 mm	–	1.34-2.24 mm	–	1.26-2.28 mm	–	1.24-2.13 mm	1.20-2.62 mm	1.38-2.78 mm	1.23-2.88 mm	–

Source : MNHN, Paris

DESCRIPTION OF HOLOPHORONT OF *MICRIXALUS BOREALIS* ANNANDALE, 1912

ZSI 16932, sex not studied. Rotung (1300 ft = 400 m), South of Yembung, Arunachal Pradesh, India.

(A) Size and general aspect. – (1) Specimen of small size (SVL 20.4 mm), body stout.

(B) Head. – (2) Head moderate, wider (HW 8.4 mm) than long (HL 7.4 mm; MN 6.6 mm; MFE 5.6 mm; MBE 3.0 mm), convex. (3) Snout rounded, not protruding; its length (SL 3.18 mm) longer than horizontal diameter of eye (EL 2.87 mm). (4) Canthus rostralis indistinct, loreal region concave, obtuse in cross section. (5) Interorbital space flat, less broad (IUE 1.83 mm) than upper eyelid (UEW 1.67 mm) but narrower than internarial distance (IN 2.49 mm); distance between front of eyes (IFE 3.8 mm) about three fourth of distance between back of eyes (IBE 6.2 mm). (6) Nostrils rounded, without flap of skin laterally, closer to eye (EN 1.17 mm) than to tip of snout (NS 1.86 mm). (7) Pupil oval, horizontal. (8) Tympanum indistinct. (9) Pineal ocellus absent. (10) Vomerine ridge and teeth absent. (11) Tongue moderate, rounded, emarginate; median lingual process absent. A prominent unique tooth-like projection medially on maxilla. (12) Supratympanic fold poorly distinct, from eye to level of lips.

(C) Forelimbs. – (13) Arm short, fore-arm (FLL 4.5 mm) shorter than hand (HAL 5.6 mm), not enlarged. (14) Fingers short, thin (F_3 2.47 mm). (15) Relative length of fingers, shortest to longest: $F_1 < F_2 < F_4 < F_3$. (16) Tips of fingers I to IV rounded, not enlarged. (17) Finger II with dermal fringe; webbing absent. (18) Subarticular tubercles indistinct, rounded, single, tubercles of finger IV absent. (19) Prepollex indistinct; palmar tubercles indistinct; supernumerary tubercles absent.

(D) Hindlimbs. – (20) Shanks three times longer (TL 11.8 mm) than wide (TW 3.6 mm), longer than thigh (FL 10.8 mm) and distance from base of internal metatarsal tubercle to tip of toe IV (FOL 10.9 mm). (21) Toes long, thin, toe IV (T_4 7.40 mm) longer than third of distance from base of tarsus to tip of toe IV (TFOL 15.7 mm). (22) Relative length of toes, shortest to longest: $T_1 < T_2 < T_5 < T_3 < T_4$. (23) Tips of toes rounded, slightly enlarged. (24) Webbing moderate: I 0 – 1 II 0 – 2 III 2 – 2 IV 3 – 1 V (MTTF 6.84 mm; MTFF 6.36 mm; FTFT 3.66 mm; FFTF 4.77 mm). (25) Dermal ridge along toe V absent. (26) Subarticular tubercles indistinct, oval, simple, all present. (27) Inner metatarsal tubercle indistinct, short, its length (IMT 1.36 mm) 1.83 times in length of toe I (T_1 2.49 mm). (28) Tarsal fold absent. (29) Outer metatarsal tubercle, supernumerary tubercles and tarsal tubercle absent.

(E) Skin. – (30) Dorsal and lateral parts of head and body: snout smooth; between eyes, side of head, back and flank roughly shagreened. (31) Cephalic ridges absent. (32) Dorsolateral folds absent; "Fejervaryan" line absent; lateral line system absent. (33) Dorsal parts of limbs: forelimb shagreened; thigh and leg roughly shagreened; tarsus smooth. (34) Ventral parts of head, body and limbs: throat with indistinct glandular warts; chest and upper belly smooth; posterior part of belly smooth. (35) Macroglands absent.

(F) Coloration in alcohol. – (36) Dorsal and lateral parts of head and body: dorsal parts of head and body brown with a dark band between eyes and a dark chevron between shoulders;

Source : MNHN, Paris

flank brown with darker spots; loreal region and upper lip brown with ivory white spots; tympanic region brown. (37) Dorsal parts of limbs: brown with indistinct darker brown bands; posterior part of thigh brown. (38) Ventral parts of head, body and limbs: throat and its margin dirty white covered with brown shade; chest ivory-white with brown spots on sides, belly dirty white; thigh dirty white with brown spots on border; webbing dirty white with few brown spots.

(G) Sexual characters. – Not observed.

Description of specimens from Mizoram

Size. – A small-sized frog (fig. 1), mature males SVL 19.96-23.95 mm (n = 4); gravid females SVL 23.14-28.12 mm (n = 7).

Head. – Head shorter than broad, small triangular. Snout blunt in shape, convex at tip projecting beyond mouth; canthus rostralis obtuse; loreal region concave; width at angle of jaws around $2^1/_2$ times distance from tip of snout to anterior corner of eye. Nostril equidistant from tip of snout and eye; length of snout slightly longer than diameter of eye; internarial distance larger than interorbital distance; tympanum round, not distinct and nearly half of eye diameter; supratympanic fold starting from posterior corner of eye and ending at level of forelimb insertion. Upper jaw bearing teeth; vomerine ridge absent; choanae situated far forward, partially covered by musculature. A tooth-like structure at apex of lower jaw, prominent and pointed; tongue small, free and bifid.

Forelimb. – Moderately strong, more than half of snout-vent length; fingers thin, small, without webbing between them; first finger slightly shorter than second; no inner metacarpal tubercle on hand. Fingers dilated into rounded discs; discs longer than broad; subarticular tubercles of hand distinct and prominent, smaller than subarticular tubercles of feet. Relative length of fingers, shortest to longest: $F_1 < F_2 < F_4 < F_3$.

Hindlimb. – Hindlimbs stout; exceeding total body length; tibiotarsal articulation reaching eyes. Heels slightly overlapping when hindlimbs folded at right angle to body. Tibia short, half of snout-vent length; its width about $^1/_3$ of its length. Toes slender; an elongated inner metatarsal tubercle present at base of first toe, followed by tarsal fold; outer metatarsal tubercle absent. Relative length of toes, shortest to longest: $T_1 < T_2 < T_5 < T_3 < T_4$. Discs of toes small, bearing a narrow median groove. Subarticular tubercles moderately prominent. Webbing small, not quite reaching discs of first and fifth toes. Webbing moderate: I 1-$1^1/_2$ II 1-$1^3/_4$ III 1-$2^1/_2$ IV 3-1 V.

Skin. – Dorsum as well as flank region rough with numerous tiny glandular warts forming net-like ridges; skin of snout, between eyes, upper eyelids and lateral side of head above the supratympanic fold uniformly granular, below fold smooth; throat and chest smooth to shagreened; belly and inner part of limbs smooth but outer limbs with minute warts; glandular warts on the outer shank larger than those of outer thigh; skin around anus shagreened to granular; anus unmodified, directed posteriorly, at upper level of thighs.

Source : MNHN, Paris

Fig 1. *Ingerana borealis* (MZU-ZOO A.46), SVL 24.35 mm, female, at Durlui (Mizoram; 23°53.508'N, 92°29.056'E, 110 m asl)

Colour Dorsal colour varying from light grey to light brown spotted with dark grey to dark brown; pupil rounded and bluish-black; flanks darker, throat and chin tinted with light grey; belly white or slightly light yellow without any markings, inner limbs including hands and feet light yellow, limbs and digits speckled with faint dark bands. A faint black line running from throat region to level of groin ventro-medially. A dark brown canthal stripe from snout to eye; one prominent white spot present between eye and upper jaw. A dark bar present at posterior region of interorbital space, snout darker. A prominent light yellow dorsolateral stripe extending from posterior corner of eye to level above insertion of hindlimb, demarcating lighter grey or light brown dorsum from darker flanks. Webbing whitish yellow.

Sexual dimorphism. - (a) Males. comparatively smaller in size; a pair of indistinct gular pouches present on throat of calling male. (b) Female. comparatively larger in size, wider abdomen during breeding season.

Distribution ANNANDALE (1912) collected the type specimens of *Micrixalus borealis* from close to Mouling National Park (Arunachal Pradesh) and after nine decades PAWAR & BIRAND (2001) rediscovered the species in Pakhui Wildlife Sanctuary and Nameri National Park. MATTHEW & SEN (2003) reported it from Baghmara Reserve Forest, South Garo Hills and Narpuh Reserve Forest, Jainta Hills (Meghalaya). AO et al. (2003) recorded it from

Source : MNHN, Paris

Medziphema (Nagaland) and ASMAT *et al.* (2003) from Rangamati Hill district in Bangladesh. The present study recorded this species from the two districts of Mizoram, i.e., Aizawl district and Kolasib district In Aizawl district they were collected in Lawibual stream (23°43 193'N, 92°44.328'E; 743 m asl), Mizoram University Campus (23°43.081'N, 92°43 668'E; 915 m asl), Tamdil National Wetland (23°44.399'N, 92° 57 313'E; 745 m asl), Durlui (23°53 508'N, 92°29.056'E; 110 m asl). In Kolasib district they were found in Tuitun stream (23°58.213'-58.402'N, 92°41.055'-41.104'E; 300-325 m asl) and Zanlawntlang Reserved Forest (23°56.116'N, 92°43 465'E; 748 m asl) The present records add not only new data to the distributional information of the species in north-eastern India, but also to the altitudinal distribution It is notable that many of these specimens, except those collected in Durlui and Tuitun stream, came from elevations above 740 m asl and up to 915 m asl; our Bhutan specimens were collected at 1000 m asl, thus extending the elevational range much above the 400 m asl given in the literature (STUART et al , 2008). This species is not rare in the two districts of Mizoram where it could be easily observed during our study. Further exploration will probably reveal that *I borealis* is present in other parts on this region, and its range may be throughout the state

Natural history. – *Ingerana borealis* is a widely distributed species in our current study sites, found in and around lotic water sources mostly in canopy area, marshes and wetlands. During our survey, most of the specimens were found at night among litter and boulder in trickling and cascading streams in and around forests. Most of them were seen perching on the wet rocks within the stream or on the streamside rock ledges, about 1-5 m away from the water surface. In Mizoram, this frog can be observed from the onset of monsoon onwards. During day time, the frogs remained inside the crevices of rock as well as under moist leaf litter and bushes. Other amphibian species found in sympatry include *Amolops marmoratus* (Blyth, 1855), *Fejervarya limnocharis* group, *Polypedates leucomystax* group, *Nasirana alticola* (Boulenger, 1882), *Sylvirana* cf *nicobarensis* (Stoliczka, 1870), *Kaloula pulchra* Gray, 1831, *Microhyla berdmorei* (Blyth, 1856), *Leptobrachium smithi* Matsui, Nabhitabhata & Panha, 1999 and *Xenophrys parva* (Boulenger, 1893).

During the present study, *Ingerana borealis* was found from April to August, which indicates that the species is a seasonal breeder. We observed that breeding in this species is related to rainfall with the breeding peak taking place from May to July. The male calls from outside water and amplexus is axillary Frogs in amplexus are seen from around 22.30 h on the margin of water, near the bank No eggs and larvae of this species have been recorded. Remarkably, in laboratory, maintained amplecting pairs did not lay eggs.

CHANDA (2002) reported that no data were available on the wild status of the species and may warrant inclusion in the Indian Wildlife (Protection) Act, 1972. The new data published here may fill this gap. As indicated from range extension and abundance in the field, this species might be changed to LC (Least Concern) in IUCN categories.

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Source : MNHN, Paris

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Fejervarya triora (Amphibia, Ranidae): first description of the adult male and recent distribution records

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We provide the first description of the adult male of *Fejervarya triora* Stuart, Chuaynkern, Chan-ard & Inger, 2006, based on a single specimen collected from Ubon Ratchathani Province, northeastern Thailand. Additional records of its distribution, based on voucher specimens, are given and a recent distribution map is provided. Our specimens represent new provincial records.

INTRODUCTION

The frog species *Fejervarya triora* was recently described from Ubon Ratchathani Province (type locality: "Phu Jong-Na Yoi National Park", Na Chaloey District, northeastern Thailand), based on a series of adult females and unsexed juvenile specimens (STUART et al., 2006). The holotype description was made from an adult female (FMNH 266172/THNHM 05325). Previously, even though CHAN-ARD (2003) provided a short description of the species in Thai as well as a life photo and a distribution map in his field guide, no information on male specimens was published. In general, local people from places surrounding the type locality are familiar with both sexes of this frog as they use it for consumption.

During a herpetological survey in 2005, we conducted field trips in several areas of Thailand. We thus obtained twenty-two specimens which we identified as *Fejervarya triora*. The frogs show external morphological characters similar to the original description given by STUART et al. (2006). This series of specimens included an adult male, which allows us to provide here the first description of an adult male of this species, accompanied by a recent distribution map.

Source : MNHN, Paris

Material and methods

The specimens were caught in the field by hand, preserved in 10 % buffer formalin, and later transferred to 70 % ethanol. Before the specimens were fixed in formalin, tissue samples were taken by preserving pieces of liver in 95 % ethanol. The specimens in this study are catalogued and deposited in the collection of the Thailand Natural History Museum (THNHM), Pathum Thani, Thailand. The description format was based on the works of Ohler (e.g., Ohler, 1996; Ohler & Dubois, 1999; Ohler et al., 2000, 2002). Data concerning the type series of the species were obtained by YC The criterion used for determination of the sex was the presence of vocal sac openings (Heyer, 2005) Webbing formula is given according to Myers & Duellman (1982). The illustration of nuptial pad morphology was made by CI using a Leica MS5 stereomicroscope with a camera lucida attachment, at the Laboratoire des Reptiles et Amphibiens, Muséum national d'Histoire naturelle (MNHN), Paris, France.

Measurements were made with digital calipers to the nearest 0.1 mm. Abbreviations used for measurements are.

SVL, snout vent length

Head: HW, head width, HL, head length (from back of mandible to tip of snout); MN, distance from back of mandible to nostril, MFE, distance from back of mandible to front of eye; MBE, distance from back of mandible to back of eye; IFE, distance between fronts of eyes, IBE, distance between backs of eyes, IN, internarial space, EN, distance from front of eye to nostril; EL, eye length, SN, distance from nostril to tip of snout, SL, distance from front of eye to tip of snout, TYD, greatest tympanum diameter; TYE, distance from tympanum to back of eye, IUE, minimum distance between upper eyelids, UEW, maximum width of inter upper eyelid

Forearm HAL, hand length (from base of outer palmar tubercle to tip of third finger), FLL, forelimb length (from elbow to base of outer palmar tubercle), TFL, third finger length (from base of first subarticular tubercle), fd1-fd4, width of pads of fingers 1 to 4; fw1-fw4, width of fingers 1 to 4

Hindlimb FL, femur length (from vent to knee), TL, tibia length, FOL, foot length (from base of inner metatarsal tubercle to tip of fourth toe), FTL, fourth toe length (from base of first subarticular tubercle); td1-td5, width of pads of toes 1 to 5, tw1 to tw5, width of toes 1 to 5, IMT, length of inner metatarsal tubercle; ITL, inner toe length.

Webbing MTTF, distance from distal edge of metatarsal tubercle to maximum incurvation of web between third and fourth toe, TFTF, distance from maximum incurvation of web between third and fourth toe to tip of fourth toe, MTFF, distance from distal edge of metatarsal tubercle to maximum incurvation of web between fourth and fifth toe, FFTF, distance from maximum incurvation of web between fourth and fifth toe to tip of fourth toe, WTF, webbing between third and fourth toe (from base of first subarticular tubercle), WFF, webbing between fourth and fifth toe (from base of first subarticular tubercle), WI, webbing between third and fourth toe when folded along fourth toe (from base of first subarticular tubercle), WII, webbing between fourth and fifth toe when folded along fourth toe (from base of first subarticular tubercle).

Source : MNHN, Paris

RESULTS

Fejervarya triora Stuart, Chuaynkern, Chan-ard & Inger, 2006
(fig. 1-3)

Fejervarya sp.: CHAN-ARD, 2003. 110.
Fejervarya triora Stuart, Chuaynkern, Chan-ard & Inger, 2006: 11.

Material examined. THNHM 09052-65, four adult females and eight juveniles, collected by N. Salangsingha and S. Makchai between 14 and 21 September 2005 at Mukdahan National Park, Muang District, Mukdahan Province, Thailand; THNHM 09069-76, an adult male and an adult female, six juveniles, collected by N. Salangsingha and S. Makchai between 23 and 25 September 2005 at Pha Tam National Park, Khong Chiam District, Ubon Ratchathani Province, Thailand

Comparative material. – See STUART et al. (2006)

Description of male specimen THNHM 09074 (field number YC 0117), an adult male, Pha Tam National Park, Khong Chiam District, Ubon Ratchathani Province, northeastern Thailand. The specimen was collected by N. Salangsingha and S. Makchai on 25 September 2005. All measurements below are in millimetres.

(A) Size and general aspect. - (1) Frog of moderate size (SVL 45.3), body slender.

(B) Head. (2) Head of moderate size, about as broad as long (HW 17.7, HL 17.6; MN 15 5; MFE 12.5, MBE 7 3), flat above. (3) Snout obtusely pointed in dorsal view, rounded in lateral view, slightly projecting beyond lower jaw, its length (SL 7.4) longer than horizontal diameter of eye (EL 6.0). (4) Canthus rostralis rounded, loreal region obtuse in cross section (5) Interorbital space flat, narrower (IUE 2.2) than upper eyelid (UEW 4 6) and than internarial distance (IN 3.4), distance between fronts of eyes (IFE 7 9) 1 6 times in distance between backs of eyes (IBE 12.4) (6) Nostrils rounded with flap of skin laterally, closer to tip of snout (NS 2.8) than to eye (EN 4.2). (7) Pupil not observed in this specimen (8) Tympanum (TYD 4.1) distinct, rounded, 69 % of eye diameter; tympanum-eye distance (TYE 1.6) 39 % of tympanum diameter. (9) Pineal ocellus absent. (10) Vomerine ridge present, bearing few small teeth ($n = 4$), with an angle of 45° to body axis, less close to choanae than to each other, longer than distance between them (11) Tongue large, oval, emarginated, bearing no median lingual process; tooth-like projections on lower jaw absent.

(C) Forelimbs. (12) Arm short, not very strong, fore-arm (FLL 9.5) as long as hand (HAL 9.5), not enlarged. (13) Fingers I, II and IV short and thin; finger III long and thin (TFL 5 6). (14) Relative length of fingers. II < IV < I < III. (15) Tips of fingers rounded, not enlarged, without grooves, narrow compared to finger width (fd1 0.9, fw1 0.9; fd2 0.9, fw2 1.0; fd3 0.7, fw3 0.9; fd4 0.7, fw4 0 9). (16) Dermal fringe on inner side of fingers II and III indistinct; webbing on fingers absent. (17) Subarticular tubercles strongly prominent, oval, single, all present. (18) Prepollex distinct, oval; palmar tubercles not separated into inner and outer metacarpal tubercles; no supernumerary tubercle

Source : MNHN, Paris

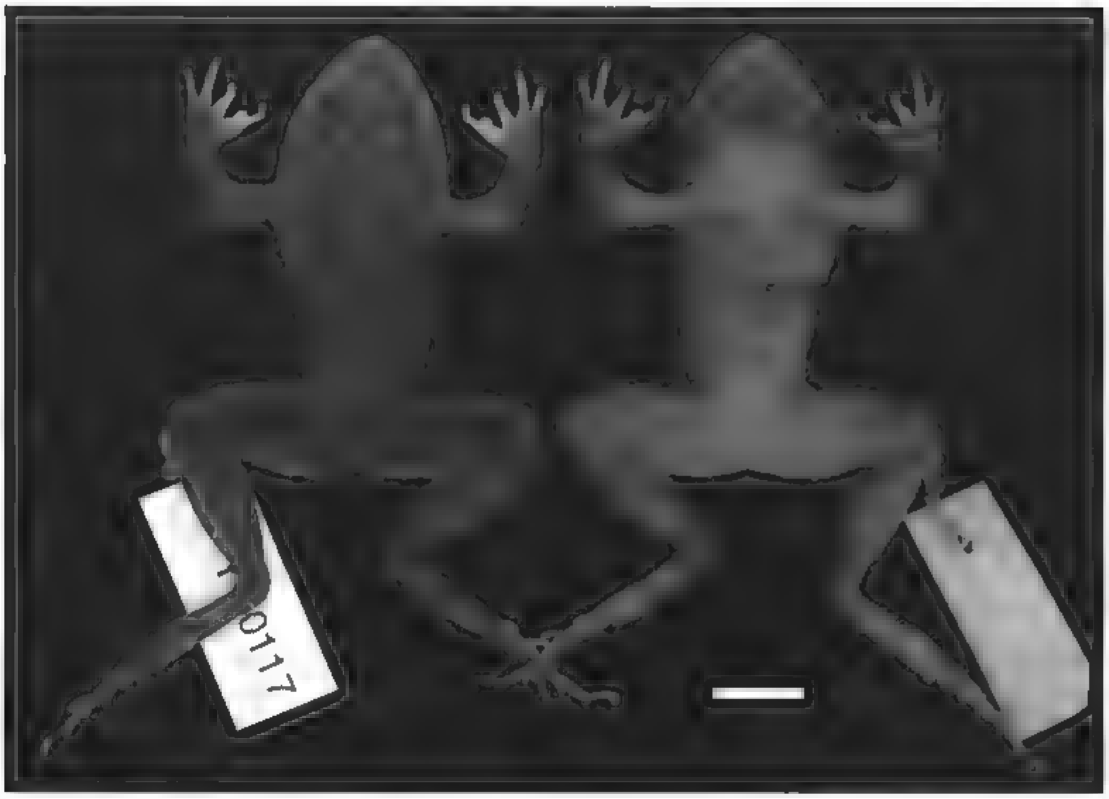

Fig 1 Adult male specimen of *Fejervarya triora* (THNHM 09074, SVL 45.3 mm.) Left, dorsal view, right, ventral view; scale bar, 10 mm

(D) Hind limbs. – (19) Hind limbs moderately long, heels overlapping when limbs are folded at right angles to body; tibia 3 3 times longer (TL 21 3) than wide (TW 6.6), longer than thigh (FL 20.7) and longer than distance from base of internal metatarsal tubercle to tip of toe IV (FOL 21 0). (20) Toes long and thin, toe IV (FTL 12.3) longer than one third of distance from base of tarsus to tip of toe IV (TFOL 30.2). (21) Relative length of toes: I < II < V < III < IV (22) Tips of all toes rounded, not enlarged; disks absent on toes I-V, without grooves, narrow compared to toe width (td1 0 7, tw1 0.7; td2 0 6, tw2 0 7; td3 0.6, tw3 0.7; td4 0.7, tw4 0.7; td5 0.5, tw5 0.6) (23) Webbing present, rudimentary: I 1 $2^{1/3}$ II 1 $2^{1/3}$ III 1 3 IV 3 1 V (WTF 3.6, WFF 3.1; WI 3 7, WII 3 1; MTTF 9 5, MTFF 9.3, TFTF 8 4, FFTF 9.6). (24) Dermal ridge along toe V present from tip of toe to distal outer metatarsal tubercle, well developed. (25) Subarticular tubercles strongly prominent, oval, simple, all present. (26) Inner metatarsal tubercle distinct, elongated; its length (IMT 3.1) 1.4 times in length of toe I (ITL 4 2) (27) Tarsal fold absent. (28) Outer metatarsal tubercle present, rounded, supernumerary tubercles and tarsal tubercle absent.

(E) Skin. (29) Snout and skin between eyes smooth, side of head smooth with few horny spinules on the area of upper lip. Anterior part of back smooth, posterior part shagreened with horny spinules. Upper part of flank, from line from insertion of arm to groin, granular with horny spinules, lower part of flank granular. (30) Dorso-lateral folds absent; supratympanic folds present and strong, from posterior edge of eyelids to shoulders, parotoid glands

Source : MNHN, Paris

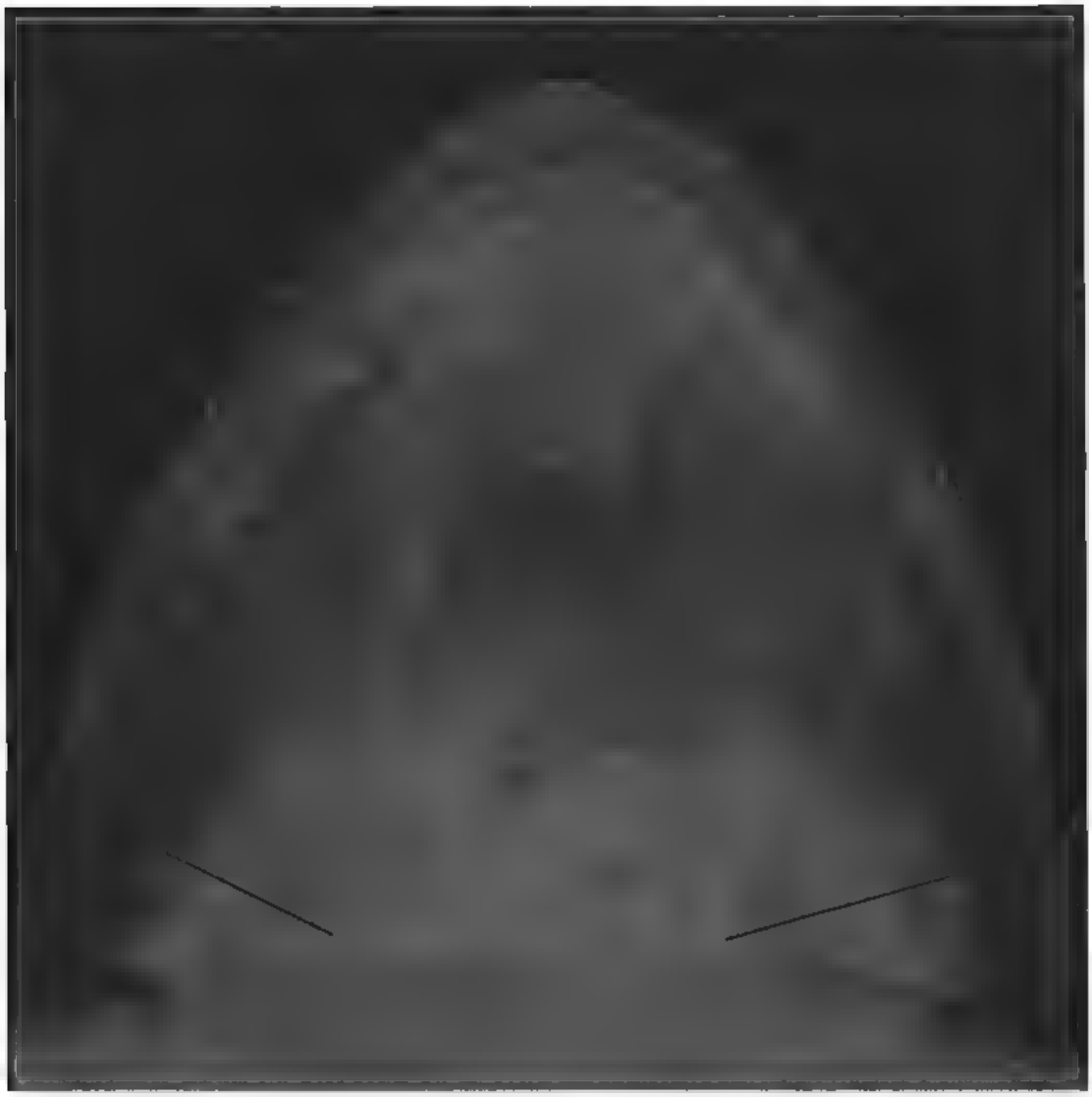

Fig. 2. – The external vocal sac (wrinkled skin pointed to by arrow) of male *Fejervarya triora* (THNHM 09074).

absent; cephalic ridges absent; co-ossified skin absent; Fejervaryan line indistinct. (31) Dorsal parts of forelimb, leg and tarsus smooth with few horny spinules; dorsal part of thigh with feeble glandular folds bearing few horny spinules. (32) Throat, chest, belly and anterior ventral part of thighs smooth; posterior ventral part of thigh with tree-frog belly skin (33) Macroglands absent.

(F) Coloration (in alcohol). – (34) Dorsal parts of head and dorsum dark grey with dark brown marbling, "V" shape band extending from edge of eyelid to each other; flank dark brown with light marbling; loreal region and tympanic region dark grey; upper lip dark grey with four feeble dark brown bands. (35) Dorsal parts of forelimb dark grey with dark brown crossbars on forearm, dorsal parts of thigh, leg and foot dark grey with black crossbars;

Source : MNHN, Paris

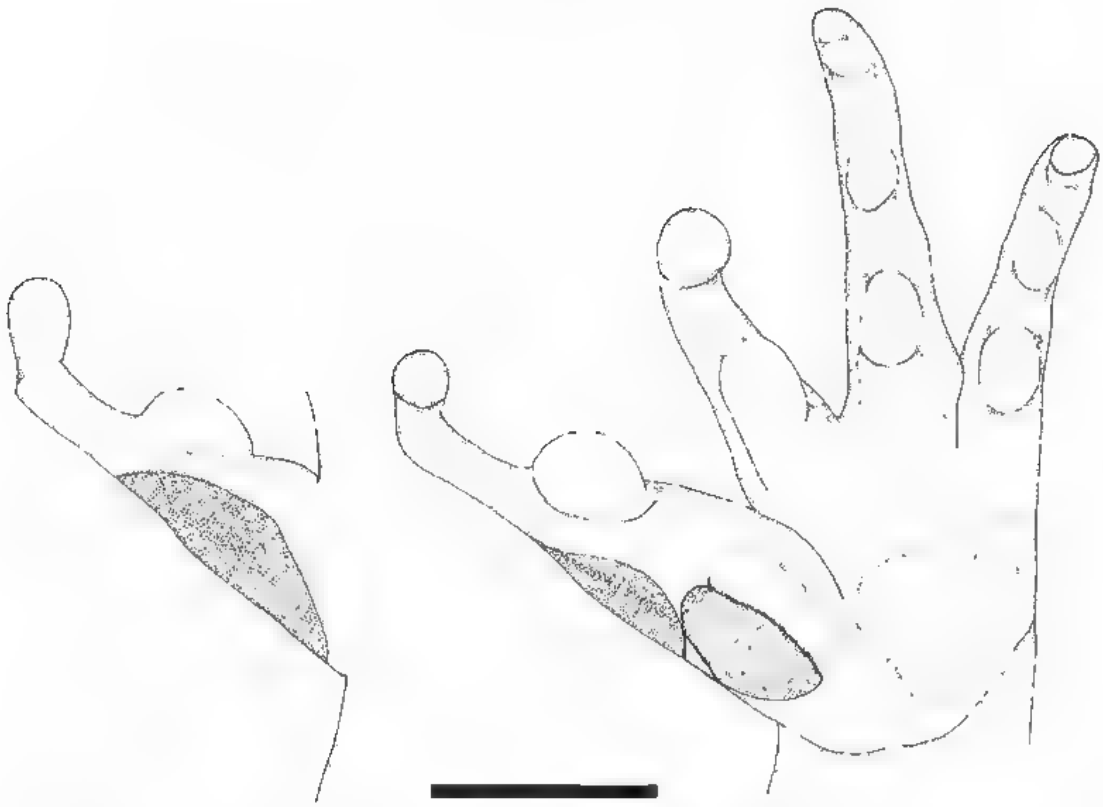

Fig. 3 — Hand of male *Fejervarya triora* (THNHM 09074) showing nuptial spines on first finger in dorsal (left, drawn from right hand) and dorsolateral (right, drawn from left hand) views. Scale bar, 30 mm

posterior part of thigh dark brown with light vermiculations. (36) Throat and its margin dark mottled on approximately 2/3 of throat; vocal sacs with dark mottling (fig. 1-2); chest and belly greyish white with more mottling in the area of breast and lateral sides of belly; webbing brown.

(G) Male secondary sexual characters — (37) Two pads in contact, oval shaped nuptial pad on finger I, with small, translucent spines (fig. 3). (38) Vocal sacs present, distinct on throat as wrinkled skin beside corners of jaws (fig. 1-2); paired openings of vocal sacs distinct, slit-like, at anterior corner of jaw. (39) Other secondary sexual characters absent.

Natural history notes. — Frogs were collected at night starting at 19h00 in deciduous forest. At Mukdahan National Park, the substrate where the frogs were found is very large igneous rock with several small hollows (containing water only in the rainy season), whereas at Pha Tam National Park it is sandstone bedrock where erosion formed several small temporary hollows. The frogs were found sitting on the ground, on dead leaves, grass, or sitting in the hollows. From the observation of NS and SM, only the juvenile frogs (tentatively so defined by their small size) were found in daytime but never adult frogs (tentatively so defined by their larger size). Adult frogs could be observed when the sun went down. Individuals of very large size were found more frequently at night when it did not rain, whereas adult male frogs (large size but smaller than females and calling) were mostly found during rainy nights.

Source : MNHN, Paris

Tab 1 – Selective measurements in millimetres (mean ± standard deviation, and min-max) of adult *Fejervarya triora* from Phu Jong-Na Yoi National Park (10 adult females, holotype and paratypes), Mukdahan National Park (4 adult females) and Pha Tam National Park (an adult female and an adult male). Measurements are defined in the *Material and methods*. Some measurements of the type series are not available, indicated as n.a., because of use of different measurement methods by YC in 2005.

	Phu Jong - Na Yoi	Mukdahan	Pha Tam			Phu Jong - Na Yoi	Mukdahan	Pha Tam	
	females	females	female	male		females	females	female	male
SVL	58.2 ± 1.7 (55.5-60.8)	57.5 ± 2.4 (55.1-60.3)	55.6	45.3	FLL	14.1 ± 0.6 (13-15.1)	13.4 ± 0.9 (12.4-14.1)	13.3	9.5
HW	24.2 ± 1.3 (22.8-27.2)	22.3 ± 1 (20.8-23.1)	21.9	17.7	TFL	6.8 ± 0.3 (6.3-7.3)	7.2 ± 0.3 (7-7.7)	6.9	5.6
HL	21.1 ± 0.6 (20-22.1)	22.2 ± 1 (21.2-23.2)	22.5	17.6	FL	28.5 ± 0.9 (27.8-30.3)	25.5 ± 1.1 (24.6-26.9)	25.6	20.7
MN	n.a.	19.2 ± 1 (18.3-20.3)	19.6	15.5	TL	30.2 ± 1 (29-32.1)	28.3 ± 0.8 (27.7-29.4)	26.4	21.3
MFE	n.a.	14.4 ± 0.8 (13.5-15.2)	14.5	12.5	FOL	29.4 ± 1 (27.5-31.1)	27.9 ± 0.8 (26.9-28.8)	26.7	21
MBE	n.a.	8.8 ± 0.7 (8.1-9.7)	9.4	7.3	FTL	16.8 ± 0.6 (15.7-17.8)	16 ± 0.3 (15.8-16.4)	15.3	12.3
IFE	n.a.	9.3 ± 0.4 (9.1-9.8)	9.3	7.9	IMT	3.8 ± 0.2 (3.7-4.1)	3.8 ± 0.3 (3.5-4.1	3.5	3.13
IBE	n.a.	14.8 ± 0.6 (14.1-15.5)	13.8	12.4	ITL	6.3 ± 0.3 (5.5-6.6)	6.2 ± 0.1 (6.1-6.3)	6.2	4.2
IN	4.4 ± 0.3 (4-4.8)	4.7 ± 0.2 (4.4-4.9)	4.3	3.4	TW	9.9 ± 0.8 (8.3-11.1)	9 ± 0.9 (8.1-10.3)	7.9	6.6
EN	5 ± 0.3 (4.4-5.5)	5.6 ± 0.2 (5.3-5.8)	5.3	4.2	TFOL	41.3 ± 1 (39.9-43)	40 ± 0.5 (39.4-40.4)	38.5	30.2
EL	6.7 ± 0.2 (6.5-7)	6.5 ± 0.2 (6.3-6.8)	6.5	6	MTTF	n.a.	13.4 ± 0.2 (13.2-13.5)	12.6	9.5
NS	n.a.	4.1 ± 0.4 (3.7-4.6)	3.3	2.8	MTFF	n.a.	13.2 ± 0.3 (12.8-13.5)	12.9	9.3
SL	9 ± 0.4 (8.3-9.4)	9.2 ± 0.4 (8.8-9.8)	8.6	7.4	TFTF	n.a.	10.4 ± 0.7 (9.4-11.1)	11.1	8.4
TYD	4.8 ± 0.2 (4.3-5)	4.4 ± 0.3 (4.1-4.7)	4.4	4.1	FFTF	n.a.	11.7 ± 0.2 (11.5-11.9)	11.2	9.6
TYF	1.5 ± 0.3 (1.2-1.9)	1.7 ± 0.2 (1.5-1.8)	1.7	1.6	WTF	n.a.	6 ± 0.9 (5.1-7.1)	5	3.6
IUE	n.a.	3.2 ± 0.3 (2.8-3.5)	3.3	2.2	WFF	n.a.	5.2 ± 0.4 (4.7-5.8)	4.8	3.1
ELW	n.a.	5.6 ± 0.6 (5-6.2)	5	4.7	W1	n.a.	5.2 ± 0.5 (4.9-6)	5.2	3.7
HAL	12 ± 0.4 (11.5-12.7)	12.1 ± 0.4 (11.7-12.7)	11.9	9.5	W2	n.a.	4.2 ± 0.8 (3.3-5.3)	4.6	3.1

Comparisons Our single male specimen has morphological characters that agree with the females described by STUART et al. (2006) in having a very broad head and a broad supratympanic fold obscuring the dorso-posterior margin of tympanum. Yet, this specimen differs from these females in its smaller size (SVL 45.3 mm, vs. 55.5-60.8 mm in 10 adult females, average 58.2 ± 1.7). This appears to be sex dimorphism in size, known in other

Source : MNHN, Paris

species of *Fejervarya* (Dubois & Ohler, 2000; Veith et al., 2001). The pineal ocellus, visible in the female specimens studied by Stuart et al. (2006), is absent in our male specimen, so this character shows intraspecific variation. The male specimen observed exhibits two palmar tubercles in contact (not separated into inner and outer metacarpal tubercles), as mentioned in the description of Stuart et al (2006). The difference might be due to preserving preparation. The skin on top of the head in our male specimen seems to be smooth, versus shagreened in the specimens described by Stuart et al (2006) This also might be caused by different conservation conditions. According to Stuart et al (2006), the type series and other specimens they examined are in good condition whereas our specimens are rather slightly stiff. Due to the poor condition of our specimen, we could not observe the flap of skin on the preaxial side of fingers II and III which were described by Stuart et al (2006) in their females. Adult female specimens from Mukdahan and Pha Tam national parks show dorsum pattern (in preservative) variable in amount of blotches or spots, as noted by Stuart et al. (2006). Measurements data show that the adult females from those three localities are in the same range (tab. 1). More specimens, especially adult males, are further required to test sexual dimorphism in this species. Nevertheless, we consider that the differences observed result either from sex dimorphism or from fixation and conservation conditions, and we assign this frog to *Fejervarya triora*.

Distribution. Thailand: Ubon Ratchathani , Na Chaloey District, Phu Jong-Na Yoi National Park (Stuart et al., 2006), Khong Chiam District, Pha Tam National Park (this study), Mukdahan Province, Muang District, Mukdahan National Park (this study).

Prior to this study, *Fejervarya triora* had only been known from the type locality. Our specimens represent the first provincial record for Mukdahan Province and also an additional provincial record for Ubon Ratchathani Province. The distribution map of this species is shown in fig 4. The species *Fejervarya triora* is currently known only from Thailand, but might be expected in Laos.

Discussion

Recently, Frost et al (2006) proposed a new taxonomy for living amphibians based on combined anatomical and molecular data The family Ranidae Rafinesque-Schmaltz, 1814 was partitioned into eleven families to avoid paraphyly with regard to the families Rhacophoridae and Mantellidae. Among them, the Dicroglossinae (sensu Dubois, 1992, 2005) were elevated to family status. The genus *Fejervarya* Bolkay, 1915 was referred to this family. In this paper we adopt a conservative attitude in using the family Ranidae in the traditional sense (Dubois, 1992, 2005, Bossuyt et al , 2006; Ohler & Dubois, 2006). Within this frame, the genus *Fejervarya* is a member of the subfamily Dicroglossinae Anderson, 1871.

As a result of this study, the male of *Fejervarya triora* is shown to have secondary sex characters similar to those indicated by Dubois et al (2001), who gave diagnostic morphological characters of nine genera of the subfamilies Dicroglossinae and Raninae of the family Ranidae For the genus *Fejervarya* Bolkay, 1915, they described the vocal sac in males as "Marked by darker coloration, and sometimes also by longitudinal folds, on sides of throat",

Source : MNHN, Paris

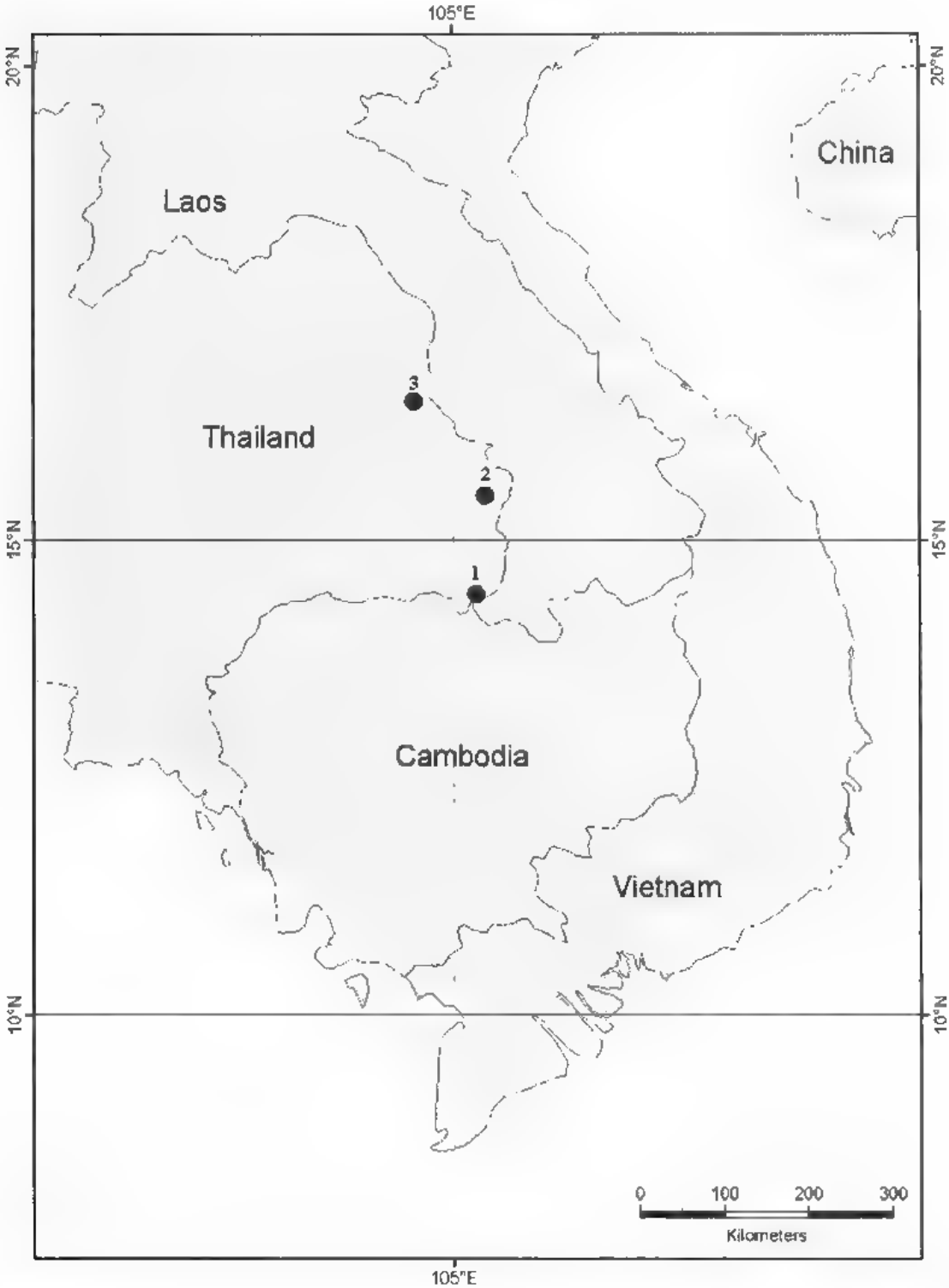

Fig. 4. Map of the Indochinese peninsula showing localities of distribution of *Fejervarya triora* reported in this study and in STUART et al. (2006). 1, Phu Jong-Na Yoi National Park (type locality), Na Chaloey District, Ubon Ratchathani Province; 2, Pha Tam National Park, Khong Chiam District, Ubon Ratchathani Province; 3, Mukdahan National Park, Muang District, Mukdahan Province.

Source : MNHN, Paris

and the nuptial pads in male as "Present on prepollex and finger I". Our adult male specimen agrees well with this information (fig. 1-3).

The male specimen was caught in September while it was calling In northeastern Thailand, this month is within the period of rainy season. The type series and tadpoles studied by STUART et al. (2006) had also been caught in September These data suggest that *Fejervarya triora* is mating during the rainy season, in contrast with *Fejervarya limnocharis*, whose tadpoles can be found throughout the year (INTHARA et al., 2005)

In the areas of study, *Fejervarya triora* is common, as also noted by STUART et al (2006) This species was much more frequently encountered than the sympatric species *Fejervarya limnocharis*. Both are consumed by local people Specimens collected for food mainly came from populations in rice fields surrounding areas protected by Thai law, such as a National Park The distribution area of *Fejervarya triora* might be much larger as currently known and we suspect that this species might be found in areas of neighbouring countries, i e., southern Laos and northern Cambodia (see fig. 4). We need a better understanding of the natural history and ecology of the species to ascertain its potential threats and managing its habitats and populations The problems of habitat loss or land use are probably among the main causes for amphibian declines (COLLINS & STORFER, 2003). It is widely assumed that the majority of amphibian populations' declines throughout the world result from habitat destruction, but this assumption is very difficult to test, because of the nature of many amphibian habitats (HALLIDAY, 2005). Attention should also be paid to the effect of harvesting on amphibian populations (VEITH et al., 2000) such as *Fejervarya triora*

During the last decade, the herpetofauna of the Indochinese region has been given significant attention. Several new species and additional records were published by various authors (e.g. TEYNIÉ et al., 2004; STUART, 2005; MATSUI & PANHA, 2006, STUART & EMMETT, 2006, GRISMER et al , 2007*a-b*; MCLEOD, 2008). The knowledge on these animals grows rapidly. Species accounts summarizing our knowledge in the form of checklists are published regularly (KHONSUE & THIRAKHUPT, 2001; ORLOV et al., 2002; NABHITABHATA et al., 2004; TEYNIÉ & DAVID, 2007). However, further work on this fauna is still necessary requiring long term study as well as study on the identities of previously named taxa.

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Source : MNHN, Paris

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Source : MNHN, Paris

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Threatened amphibians

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Simon N. STUART, Michael HOFFMANN, Janice S. CHANSON, Neil A. COX, Richard J. BERRIDGE, Pavithra RAMANI & Bruce YOUNG, B. E., (ed.), 2008. ***Threatened amphibians of the world.*** Barcelona (Lynx Edicions), Gland (IUCN) & Arlington (Conservation International): i-xv + 1-758.

1. Threatened amphibians of the world, and much more

Annemarie OHLER

When we started working on the project to establish the conservation status of all known amphibian species of the world, it seemed a rather impossible goal. All of us who are working on these species are aware of how little we actually know. But it was an exciting goal and I went to the workshops on Asian amphibians. It was fun, hard work, many people to meet, knowledge to share. And then we realized that there is much more information in the peoples' mind than in all the books. And this is the strength of this opus: the knowledge of those 500 listed in the dedication, put together under the perceptive and generous guidance of Simon Stuart and his team, resulted in this monumental book of about 800 pages.

Why a book in the age of internet? Just go to the IUCN website [http://www.iucnredlist.org/amphibians] and you will find what you search! Most of scientific knowledge today is accessible on the web only. Nevertheless the book is much more. Open it and frogs come into your life. Turn the pages and many more. And not only to the life of herpetologists, conservation specialists, but to any politician, administrative person, journalist or just reader who takes the book on a shelf will dive immediately in the exciting diversity of amphibians, as Julia Marton-Lefèvre says in her foreword: "*After reading this book and contemplating all these pictures, no one will look at amphibians with the same eyes*". And here is the strength of a book, in its physical existence, the smell of the printed pages, the brilliance of the paper, the layout that guides you, the information that is concentrated in one page, giving with a glimpse a name, a photo, a distribution, a conservation status on a species and by turning the pages you see the colours, the shapes, the richness and diversity.

The book has three major parts. The introductory chapter presents the amphibians, the Global Amphibian Assessment, and the state of knowledge on these animals by biogeographic regions, closing by a chapter on amphibian conservation. The main part is a presentation of all species according to their status of threat. The book then gives a list of references, and a series of appendices concerning the IUCN categories and lists of species presented under various criteria, a glossary of terms and websites and amphibian-related resources.

Source : MNHN, Paris

A book review clearly cannot summarize all the subjects raised in this book. Just take the chapter that introduces the amphibians. You can find distribution maps of all amphibian families. Such maps have not been published since VIAL's book in 1973 and here you can find them based on the latest classifications proposed and with very fine details that indicate distribution gaps, if existing. Similarly, maps on endemism, data on median range size of amphibian species or maps showing the world's countries according to their relative proportions of world's amphibians or relative proportions of threatened amphibians showing a large bulging south and central America and reducing Eurasia and north America to a fine stripe. These are only examples of how the data available have been exploited and presented in tables, figures and maps. A nice idea is the sections called "Essays" that initiate to specific subjects concerning amphibian biodiversity, aspects particular for the different biogeographic realms and conservation study.

All species of amphibians showing different threats are presented beginning with the species that have to be considered extinct. Species are listed in alphabetical order. For every species its conservation status, systematic position, distribution and current population trend are given with a map and photo of species, if available. Then the geographic range, the information available on population status, the species' habitat and ecology, major threats and conservation measures are described. Sources indicate bibliography and persons that provided the data presented. What is lacking is size indication for the species, as some are as small as 20 mm others might have more than 100 mm.

In the appendices, many complementary data can be found. The IUCN critera are presented and explained. The reader finds the Amphibian Conservation Action Plan and conservation required for every species concerned. The status of species according to their IUCN red list is analysed by genus and by country. Other information given in tables, such as the list of rapidly declining species or the list of critically endangered species, helps to point to conservation issues. The list of species that need immediately ex situ conservation action may help immediate action plans. To be complete the list of least concern and data deficient species as listed in 2007 is given. The species evaluated differently by the Brazil GAA workshop and the team that checked for consistency of the GAA work are listed in order not to wipe out such differences. Finally, after a glossary of some key terms and a list of websites on amphibians, the book closes with an index to extinct, threatened and near threatened species by genus and species name.

This book should be present in any office dealing with conservation issues, in public and private libraries but also on the desk of researchers and field workers. It may guide political decisions, but also help preparing research and conservation plans. It is both useful and nicely done. To use without moderation!

Many people from all over the world worked together to complete the book but all this effort to make people participate could not hide an important gap. When checking for the origin of the authors, it is quite nice to see that many authors come from the countries concerned. An exception is still Africa. In herpetology it is reduced to South Africa and since the First World Congress of Herpetology in 1989, when I entered herpetologists' world, this did not change. Here clearly is a need for capacity building, so that conservation could be more focused on high biodiversity regions and threatened species that are in southern countries (BRITO, 2008).

And to finish with good news and to go on adding data, *Conraua derooi* Hulselmans, 1972, listed as critically endangered, possibly extinct, is still alive. Gabriel Segniagbeto and myself saw in May 2007 several adult specimens of this frog in two locations of the stream at Missahohé in Togo. Its occurrence is limited, it must be considered critically endangered, but forest habitat is still available. It is still time to act.

2. The special message from threatened amphibians

Alain DUBOIS

Many books, reports and papers are available concerning threatened birds and mammals, many actions taken for ex situ and in situ conservation of some of the species of these two groups, a number of

Source : MNHN, Paris

Table 1. Average yearly increase in species number recognized by taxonomists over 10 periods from 1768 to 2002 (DUBOIS, 2004) and from 2003 to 2008 (DUBOIS, unpublished). The values marked * only give the number of new taxa described over this period but do not take synonymisations into account, so they are certainly slightly overestimated. The value for 2008 is that given on the website *AmphibiaWeb* on 21 January 2009.

Date	Total number of species recognized	Average yearly increase in species number since preceding date	Date	Total number of species recognized	Average yearly increase in species number since preceding date
1768	57	–	1992	4522	63 4
1854	234	2.1	1997*	4975	90 6
1882	1003	27.5	2002*	5472	99 4
1969	3343	26.9	2007*	6116	128 8
1984	4015	44.8	2008	6452	336 0

which are widely known even among the public at large In contrast, "lower vertebrates", not to mention "invertebrates", have until now attracted much less attention from laymen, conservationists and even biologists. The impressive book *Threatened Amphibians of the World* (*TAW* below) therefore fills a large gap hopefully, amphibians will now be fully considered when conservation plans are prepared and when research priorities are decided upon Beside all the positive aspects of this book stressed above by Annemarie, this book also sends us several important messages, some of which concern only amphibians whereas others are more general.

The models of conservation biology developed for birds and mammals do not have generality over the whole animal kingdom For amphibians, it is clear that ex situ conservation can only be very marginal It can apply only to a few species that accept captivity and for which we know the basic needs and are able to cover them Furthermore, it is of limited interest whenever the habitat where these species lived has disappeared Are we going to keep captive populations of amphibians in zoos, aqua-terraria or "tanks" for decades, without any possibility to put them back in their natural ecosystems? This may be meaningful and worthy the effort for a few species used as experimental material in research, or for very beautiful or unusual species, but it cannot apply to the thousands of species of amphibians that are going to get extinct in the current and next decades. This is even worse for many invertebrates, for which we only have a very limited experience of captive breeding, and the number of species threatened with extinction is greater by several orders of magnitude.

For most amphibians, just like for many other "small" continental organisms, the main factor of extinction is not direct destruction by man (through hunting, fishing or voluntary destruction), as the latter concern only a few "well-known" species of large size, widely distributed and often living in anthropic habitats. Even the peculiar ecological or genetical factors of threat identified and usually highlighted by conservation biologists, like fragmentation of metapopulations, consanguinity, road traffic, predation by and competition with invasive species or domestic animals, pollution, acid rains, ultraviolet or other radiations, parasitism or diseases (except for chytridiomycosis in some areas), play only a marginal role in amphibian extinctions at world-scale level. The most important factor is by far and "simply" the complete destruction of habitats, especially humid zones and forests. The case of the tropical forests of Sri Lanka, more than 95 % of which have been wiped out in the last century (MANAMENDRA-ARACHCHI & PETHIYAGODA, 2005), is exemplary. As most amphibian species have a very limited distribution range, destruction of any tropical forest results in the immediate extinction of numerous species, many of which are still unknown to science. Unfortunately, worldwide destruction of habitats is a phenomenon on which "conservation biology" can only very marginally act National and other natural parks can only protect some particularly exceptional or "spectacular" habitats, but only a fraction of the total number of amphibian species.

The book puts focus on several regions and taxa, but this is only one part of the story The most important problem is perhaps that the species and habitats for which we have enough data to make precise

Source : MNHN, Paris

estimates of the status and threats, and to propose conservation actions, are only a small minority of the total. In this respect, the situation in amphibians is drastically different from what it is in birds, the animal group which has attracted the most important conservation efforts until now, because in birds a lot more is known about the species, their needs and threats. A first strong conclusion of this book is how little we know about the current situation of many amphibian species of the planet, despite the enormous amount of work devoted to the task of building the database which made *TAW* possible. Of a total of 5915 species surveyed in the book, 1387, i.e., 23.4 %, are considered "data deficient" at the end of this survey. If one considers a rate of error of 5 % as a standard yardstick for acceptable errors and missing data in scientific research, then it is clear that our current knowledge of amphibian taxa and populations is insufficient to qualify as a satisfactory *scientific* knowledge. Furthermore, this rate is still an underestimation, both quantitatively and qualitatively.

The book reviews data bearing on almost 6000 species of Amphibia worldwide. Although impressive, this number is certainly much below the number of amphibian species *still* living on earth. At the end of 2008, taxonomists recognized about 6500 amphibian species (this is only a rough estimate, because disagreements exist between specialists about the status of many taxa). This number was about 5000 in 1997 and about 4000 in 1984. Many new species are described each year, and even if a few of the new nomina are later shown to be synonyms, the mean increase has been around 100 new species per year in the last decade. Is this number progressively decreasing? No, much less to the contrary, as shown in table 1. In 2008, for the first time in the history of zoology, more than 300 new amphibian species were described by taxonomists. No indication exists that the curve of increase in the number of known species of amphibians is approaching an inflexion point that would precede a stabilisation of this curve (Stevskal, 1965, Dubois, 1977, 1998). It is much more likely that, after having surpassed the number of species of mammals (Glaw & Kohler, 1998), the number of known species of amphibians will soon exceed that of reptiles, and several authors (Dubois, 2004: 22, Parra et al., 2005: 45) have recently expressed the idea that the number of amphibian species described is probably only half or less than half the number of species actually still present on the planet. However, no precise estimate exists for the total number of amphibian species still living on earth today, and of those that were living, say, one or two centuries ago, before large deforestations took place in most tropical regions: the latter number was probably significantly higher.

Where are the new species currently being described? Table 2 provides data on this question. These data are approximate, especially as different taxonomic approaches result in rather different estimates of the numbers of species by countries, as shown in this table by the figures borrowed from the online database *AmphibiaWeb* (*AW*) [http://amphibiaweb.org/] and from *TAW*. However, they clearly show that the "taxonomic effort" is very unevenly distributed on the planet. The highest proportional increase in the number of known species over the period 1998-2007 was in Sri Lanka (about 40 %), then in Chile, Madagascar, Papua New Guinea, Peru and Vietnam (about 25 %). These are mostly tropical countries with still important forest remnants. The amphibian specific richness can be correlated with various ecological and geographical parameters (Gallant et al., 2007, *TAW*), but, to put the things very briefly, it is above all correlated with latitude. Table 3 shows that, over the whole planet, the mean species density of known species is higher than 330 species by 1,000,000 km^2 in the ribbon of 20 degrees of latitude on each side of the equator, and may be much higher in this intertropical zone in some realms (Australasian, Neotropical and Oriental). Then this density goes decreasing rather regularly towards either the North or the South.

However, the number of newly described species does not follow exactly this pattern (table 3), the highest number being in the latitudinal band 10-19°S. This is in part because more than half of the species described from 1998 to 2007 were from the Neotropical realm. This region is currently the matter of much more taxonomic effort for amphibians than the other tropical areas. In contrast, not a single new species was described from 1998 to 2007 in 12 species-rich countries (where about 50 species or more have already been reported). Ten of these countries are in Africa (numbers between parentheses: total species number of country according to *AW*/*TAW*): Congo Democratic Republic (214/211), Nigeria (108/103), Angola (90/99), Ghana (76/76), Malawi (64/76), Central African Republic (57/62), Sierra Leone (50/55), Zimbabwe (47/63), Liberia (44/56) and Equatorial Guinea (29/70). Two of these countries are in the Neotropical realm: Paraguay (76/74) and Haiti (57/51). There is no such country in the Australasian,

Source : MNHN, Paris

Table 2 - Total amphibian species known (SN) in 2008 and increase in species (and subspecies) number (SI) from 1998 to 2007 in various countries and the six biogeographic realms of the world. The value of SN is given according to *AW* and to *TAW* (see text), respectively as SN(AW) and SN(TAW). No value is given in *AW* for the realms The value of SI is given according to DUBOIS et al (2005 and unpublished). New species and subspecies are here referred only to the country including their onymotope (type-locality) but their distribution may be wider The rate of increase, RI (100 SI SN) is given according to both values of SN. The mention *nd* means "no data"

Realm	Country	Surface (km²)	Latitude	SN(AW) 2008	SN(TAW) 2008	SI 1998-2007	RI(AW) (%)	RI(TAW) (%)
Afrotropical	Cameroon	469,440	06°00'N	195	196	12	6 2	6 1
	Ethiopia	1,119,683	08°00'N	65	63	2	3 1	3 2
	Gabon	257,667	01°00'S	44	87	4	9 1	4 6
	Guinea	245,857	11°00'N	63	74	2	3.2	2.7
	Ivory Coast	318,000	08°00'N	57	91	6	10.5	6 6
	Kenya	569,250	01°00'N	105	96	3	2.9	3.1
	Madagascar	581,540	20°00'S	244	227	54	22.1	23.8
	Mozambique	784,090	18°15'S	61	67	1	1 6	1 5
	Namibia	825,418	22°00'S	38	48	1	2.6	2.1
	Sao Tome & Principe	1,001	01°00'N	7	6	1	14.3	16 7
	Seychelles	455	04°35'S	12	12	2	16.7	16 7
	South Africa	1,219,912	29°00'S	117	115	5	4 3	4 3
	Tanzania	886,037	06°00'S	183	162	31	16.9	19.1
	Uganda	199,710	01°00'N	52	62	1	1.9	1 6
	Zambia	740,724	15°00'S	85	84	1	1.2	1 2
	All other countries (34)	14,552,463	17°00'N – 29°30'S	0 – 214	0 – 211	0	0	0
	TOTAL AFROTROPICAL (49)	22,771,247	17°00'N 29°30'S	*nd*	969	126	*nd*	13 0
Australasia	Papua New Guinea	452,860	06°00'S	294	247	69	23.5	27 9
	New Zealand	268,021	41°00'S	7	7	1	14.3	14 3
	Australia	7,617,930	27°00'S	226	218	11	4.9	5 0
	All other countries (7)	78,061	15°12'N – 21°30'S	0 – 17	0 – 20	0	0	0
	TOTAL AUSTRALASIA (10)	8,416,872	15°12'N 41°00'S	*nd*	544	81	*nd*	14.9

Source : MNHN, Paris

Table 2. – (continued 1)

Realm	Country	Surface (km²)	Latitude	SN(AW) 2008	SN(TAW) 2008	SI 1998-2007	RI(AW) (%)	RI(TAW) (%)
Nearctic	Canada	9,093,507	60°00'N	43	48	0	0	0
	United States of America	9,161,923	38°00'N	292	279	26	8.9	9 3
	TOTAL NEARCTIC (3)	18,255,483	60°00'N 32°20'N	*nd*	327	26	*nd*	8.0
Neotropical	Argentina	2,736,690	34°00'S	158	157	6	3 8	3 8
	Bolivia	1,084,390	17°00'S	225	209	41	18 2	19 6
	Brazil	8,456,510	10°00'S	806	753	125	15 5	16 6
	Chile	748,800	30,00'S	55	56	14	25 5	25 0
	Colombia	1,038,700	04°00'N	736	699	78	10.6	11 2
	Costa Rica	50,660	10°00'N	187	181	11	5.9	6.1
	Cuba	110,860	21°30'N	64	60	8	12.5	13.3
	Ecuador	276,840	02°00'S	474	451	31	6.5	6.9
	El Salvador	20,720	13°50'N	28	32	1	3 6	3 1
	French Guiana	83,534	04°00'N	97	105	6	6 2	5 7
	Guatemala	108,430	15°30'N	136	138	14	10 3	10 1
	Guyana	196,850	05°00'N	122	119	15	12.3	12 6
	Honduras	111,890	15°00'N	103	118	14	13.6	11 9
	Mexico	1,923,040	23°00'N	357	365	43	12.0	11.8
	Nicaragua	120,254	13°00'N	67	69	3	4.5	4.3
	Panama	75,990	09°00'N	197	197	11	5.6	5 6
	Peru	1,280,000	10°00'S	460	413	113	24 6	27 4
	Puerto Rico	8,870	18°15'N	25	24	1	4.0	4.2
	Suriname	161,470	04°00'N	86	103	1	1 2	1 0
	Trinidad & Tobago	5,128	11°00'N	35	34	1	2 9	2.9
	Uruguay	173,620	33°00'S	43	43	1	2 3	2 3
	Venezuela	882,050	08°00'N	321	302	45	14 0	14 9
	All other countries (23)	525,554	24°15'N 23°00'S	1 – 76	0 – 74	0	0	0
	TOTAL NEOTROPICAL (45)	20,180,850	24°15'N 34°00'S	*nd*	2916	583	*nd*	20 0

Source : MNHN, Paris

Table 2. (continued 2).

Realm	Country	Surface (km^2)	Latitude	SN(AW) 2008	SN(TAW) 2008	SI 1998-2007	RI(AW) (%)	RI(TAW) (%)
Oriental	Burma (Myanmar)	657,740	22°00'N	84	79	3	3 6	3 8
	Cambodia	176,250	13°00'N	44	44	6	13 6	13 6
	China	9,326,410	35°00'N	345	330	49	14 2	14 8
	India	2,973,190	20°00'N	263	237	54	20.5	22 8
	Indonesia	1,826,440	05°00'S	306	354	59	19.3	16.7
	Laos	230,800	18°00'N	82	73	12	14 6	16 4
	Malaysia	328,550	02°30'N	210	205	14	6.7	6 8
	Nepal	143,181	28°00'N	44	46	3	6.8	6.5
	Pakistan	778,720	30°00'N	20	18	2	10.0	11.1
	Philippines	298,170	13°00'N	102	103	12	11 8	11.7
	Sri Lanka	64,740	07°00'N	107	102	42	39.3	41.2
	Thailand	511,770	15°00'N	124	130	14	11 3	10.8
	Vietnam	325,360	16°00'N	165	145	39	23.6	26.9
	All other countries (9)	235,500	27°30'N 08°50'S	0 - 43	1 54	0	0	0
	TOTAL ORIENTAL (22)	17,877,091	35°00'N 08°50'S	*nd*	999	309	*nd*	30 9
Palaearctic	Israel	20,330	31°30'N	8	7	1	12.5	14 3
	Italy	294,020	42°50'N	48	40	2	4.2	5 0
	Japan	374,744	36°00'N	65	64	2	3 1	3 1
	Morocco	446,300	32°00'N	14	12	2	14 3	16 7
	Portugal	91,951	39°30'N	20	22	1	5 0	4 5
	Serbia	77,474	44°00'N	21	21	1	4.8	4 8
	South Korea	98,190	37°00'N	17	16	2	11.8	12 5
	Spain	499,542	40°00'N	32	44	4	12.5	9 1
	Turkey	770,760	39°00'N	29	26	1	3.4	3 8
	All other countries (71)	40,058,282	64°00'N - 15°00'N	0 40	0 39	0	0	0
	TOTAL PALAEARCTIC (80)	42,731,593	64°00'N - 15°00'N	*nd*	468	16	*nd*	3 4
TOTAL	209 COUNTRIES	130,233,136	64°00'N – 41°00'S	*nd*	6223	1141	*nd*	18 3

Source : MNHN, Paris

Table 3 Mean amphibian species density (by 1,000,000 km²), computed from the total number of species by area according to *TAW*, and number of species and subspecies described as new from 1998 to 2007, in countries of surface above 50,000 km², according to their "mean" latitude and in the six biogeographical realms (from the data of tab 2) New species and subspecies are here referred only to the country including their onymotope (type-locality) but their distribution may be wider The mean species density (MSD) is given first, followed after oblique bar by the number in bold of species described as new (NS)

Latitude	Afrotropical	Australasia	Nearctic	Neotropical	Oriental	Palearctic	All realms
60-69° N	–	–	5.28 **0**	–	–	3.05 / **0**	3.80 / **0**
50-59 N	–	–	–	–	–	107.12 / **0**	107.12 / **0**
40-49 N		–	–	–	–	58 06 / 7	58.06 / 7
30 39 N		–	30.45 **26**	–	34 44 **51**	45.32 **8**	35 31 **85**
20-29 N	–		–	211 31 / **51**	109.57 / **60**	6.46 / **0**	61.77 / **111**
10-19 N	45 92 **2**	982 32 **0**		1478 74 **42**	320 88 **83**	11.36 **0**	152 06 **127**
00-09 N	176 31 / **24**	2183.41 / **0**	–	625.36 / **156**	976.12 **56**	–	333 62 / **236**
00 09 S	249 31 **35**	555 79 **69**		1629 10 **31**	195 50 **59**	-	353 33 **194**
10-19 S	114.08 / **2**	65 64 / **0**	-	127.07 / **279**	–	–	124.22 / **281**
20-29 S	153.93 / **60**	28 68 / **11**		186.26 / **0**	–	–	73.17 / **71**
30-39 S	–	–	–	69 96 / **21**		–	69.96 / **21**
40-49 S	–	26.12 / **1**	–	–		–	26 12 / **1**
Mean MSD **Total NS**	120 81 **123**	59 05 **81**	17 91 **26**	243 65 **580**	113.55 **309**	23 38 **15**	88 46 **1134**

Source : MNHN, Paris

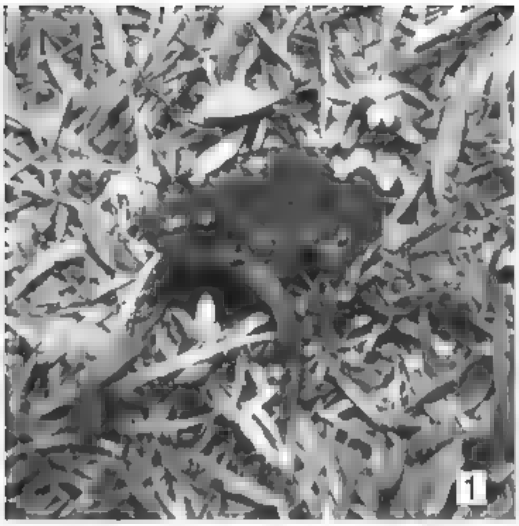

Fig 1. *Chaparana (Paa) minica* (Dubois, 1975). Adult ♂, MNHN 1989 2078, Dobhi (1520-1550 m), between Katrain (32°07'N, 77°08'E) and Raison, Himachal Pradesh, India, 4 August 1977 (photo A Dubois).

Fig. 2 "*Ombrana sikimensis* (Jerdon, 1870)" Young ♂, MNHN 1974 1504, Namdu Khola (27°06'N, 87°48'E, 2000-2060 m), between Kalikharka and Ito, Nepal, 15 May 1973 (photo A Dubois)

Nearctic, Oriental and Palaearctic realms, but several other species-rich countries in these realms have witnessed a very low rate of taxonomic increase in this period (see table 2 for details) These data suggest that some parts of the world, especially in tropical Africa but also elsewhere, are currently almost completely abandoned by amphibian taxonomists and field naturalists, mostly for political reasons (wars, dictatorships, domestic troubles, economic problems)

Finally, even for species that have been described, for which there seems to exist no important taxonomic problem, and sometimes mentioned a good number of times in the literature, the information available on their distribution, habitat and mode of life is too scanty for allowing a proper estimate of their conservation status. Let us just consider the stream frogs of the tribe *PAINI* of the *RANIDAE DICROGLOSSINAE* (OHLER & DUBOIS, 2006) All these frogs are strictly dependent on running water for breeding, larval development and most of their life (LIU, 1950, DUBOIS, 1976) and they are therefore threatened by any change in water regime in streams, e.g , caused by deforestation, dam construction or water exploitation and management by man (DUBOIS, 1980, 2000) As such, all the 42 known species of this tribe should be considered at least as "vulnerable" However, the choice of species in *TAW* (p. 490-492) is difficult to understand Four species are listed as "endangered" and eight as "vulnerable", although some of these have a rather wide distribution Apparently some were considered "endangered" for being consumed by man, but others that are also harvested (e g , *Chaparana liebigii*) were not listed The species *Chaparana minica* (fig 1) is considered as "vulnerable" although it is present in most water courses between 1000 and 2500 m in a rather large area, from western Nepal to Himachal Pradesh through Himalayan regions of Uttar Pradesh (DUBOIS, 1976) and most likely present in the Nanda Devi Biosphere Reserve of the latter state (DUBOIS & DINESH, 2007) In contrast, the species listed by FROST et al. (2006) as *Ombrana sikimensis* (fig. 2), but not mentioned in *TAW*, has a range of similar size (from central Nepal to Sikkim), but in this region it has a very scattered distribution, being restricted to a few relict forested areas at rather low altitudes (DUBOIS, 1976) and is therefore very vulnerable. Some *PAINI* species which are known only from a few specimens (*Chaparana arnoldi*, *Chaparana ercepeae*) are listed in *TAW* as "near threatened", but others are not at all mentioned in the book although they are known only from a few specimens and one or a few localities, such as *Chaparana aenea* (see DUBOIS & OHLER, 2005), *Chaparana rarica* or *Gymnodropaa bourreti*, or even from a single holotype (*Gymnodropaa feae*)

Source : MNHN, Paris

Of course, it would be easy to say that, if I had attended the Global Amphibian Assessment meetings, where I was invited, I could have modified the situation by providing unpublished information, and I certainly regret not to have been able to do so, but this example among many other possible ones shows how *fragile* is the information on which many decisions taken in this book are based. In numerous cases, only one or a few persons are aware of some unpublished information that may be crucial for ascertaining the conservation status of a species. In amphibians we are not in a situation like in birds, where many field naturalists, amateur ornithologists, "bird-watchers", observe many species each year, thus providing much useful information and being able to call almost immediately the attention to sudden problems concerning a species. Hopefully, "frogs and salamanders watching" will develop, in part thanks to the many colourful field guides that are now regularly published in various countries, but we are still far from having a complete network of competent and vigilant batrachologists all around the world. This will probably be long and hard to establish. The field identification of amphibians is much more difficult than that of birds, because visual clues (colours, conspicuous behaviours) are much less abundant and reliable in frogs, as they played a minor role in speciation in this group (see Dubois, 1988).

As well stated by Parra et al. (2005), and briefly reminded in *TAW* (p. 18, 45), taxonomy plays a major role in species conservation. A strategy of conservation biology that would rely on a grossly incomplete or faulty taxonomy would not only be useless but might be harmful. The taxonomy of amphibians is currently in a very incomplete stage, covering perhaps less than half the species of the planet. Any biologist who feels concerned with the need to protect and conserve these extraordinary animals should therefore also feel concerned with supporting taxonomic research. This may require some change in the priorities of the international community of batrachologists. For the time being, this community has put an enormous amount of collective effort into providing information about phylogenetic relationships between major amphibian groups (e.g., Frost et al., 2006) and in compiling an enormous database regarding the conservation status of many known species (*TAW*). These works are extremely useful, but they won't be enough for an efficient action for the conservation of as many of these animals as possible for the future generations.

Furthermore and unfortunately, in many cases such an action will prove impossible, whenever destruction of the habitat is unavoidable. In such situations, it would be of the greatest importance at least to conserve "pickled" specimens, tissues, observations, photographs, call recordings, etc. (Dubois, 2003). In many cases, this may be more realistic than claiming that we will "save" all the amphibians. The community of batrachologists should be careful in well defining its priorities, not only regarding the geographical foci of our works (Brito, 2008), but more generally in giving taxonomic research, collection, study, description and naming of species preeminence in the works to be carried out in this century. An important problem that will have to be solved soon is the conflict between taxonomy and conservation biology regarding the possibility to collect specimens in the field for taxonomic research: as long as conservation biology acts as a break against the collection of specimens, it will act as a break against taxonomic research, thus against knowledge and, in the long run, against the conservation of biodiversity itself (Dubois, 2003, Dubois & Nemésio, 2007).

If taxonomists continue their descriptive work at a "usual" pace, without a strong voluntary action to accelerate it, centuries may be necessary to complete the taxonomic inventory of animal species on earth (Gonzalez-Orija, 2008). Compared to other groups however, the situation may be rather favourable in amphibians. These are relatively large animals, that live in habitats usually accessible to man, and it should be possible, if our community decided to make it a major priority, to develop an international, collaborative strategy, for carrying out as quickly as possible an "exhaustive taxonomy" of this group (Dubois, 2008). If indeed there are 10-15,000 species of amphibians on earth, and if 300 of them are described each year from now on, including in regions that have so far been neglected, a subcomplete inventory of this group should be feasible within a span of 20-30 years. But time is running short and extinctions are going quicker than our decisions. If an exhaustive taxonomy of amphibians is not considered a scientific priority and implemented by the coming generation of batrachologists, it will be too late for ever for many species.

Source : MNHN, Paris

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